VIBRATION ISOLATION OF COMPUTING DEVICE HEAT SINK FANS FROM ATTACHED FAN SHROUDS AND HEAT SINKS

BACKGROUND

Field of the Invention

[0001] The present invention is in the field of computing systems and more particularly in the field of cooling microelectronic devices within a system and reducing acoustical noise generated by the system.

Background

[0002] In a competitive market, particularly the market for personal computing devices, customers will weigh the characteristics of products from multiple producers before a purchase is made. Different customers and geographies, have dissimilar opinions with regards to what makes a "quality" computing device. The most commonly sought after attributes of a computing device are processor speed, disk capacity, memory size, cost, graphics capability, form factor, and appearance. These attributes tend to be comparable among the various producers of computing systems.

[0003] The most rapidly growing area of interest for customers is acoustics or noise. Many customers now weight the acoustical characteristics of a system as highly significant in determining the quality of the system. Currently the primary elements operative in the production of system acoustical noise are the system's various electro-mechanical cooling fansthe including system fans, microelectronic component fans, and power supply fans.

[0004] Microelectronic component fans, commonly known as fan-sinks, include a fan and heat sink assembly utilized to cool an individual microelectronic component. A fan-sink includes a heat sink, a fan, and a fan-shroud, which affixes to the heat sink and to which the fan is affixed. Conventional fan shrouds rigidly tie together the fan and the heat sink. Initially, the fan is affixed and secured to the fan shroud by screws, typically four. Next the fan/fan-shroud sub-assembly is affixed to the heat sink by tabs (typically four) that are bent around the base of the heat sink. This rigid mounting scheme can cause excitement between the fan and the fan shroud and between the fan shroud and the heat sink. This excitement creates undesired sound power and an increased sound pressure at the operator's position. It would be desirable to

reduced or eliminate the transmission of vibration in a fan sink assembly and thereby reduce the sound power and pressures experienced by the end-user.

SUMMARY OF THE INVENTION

[0005] The problem identified above are addressed by a novel fan/heat sink assembly according to the present invention. The assembly incorporates a vibration isolating element into the assembly of fan and heat sink. The vibration isolating element is interposed between the fan and any other elements of the assembly affixed to it. The transmission of vibrational energy is reduced or eliminated by the use of a material, such as an elastomer, with a high damping coefficient, for the vibration-isolating element. Such a material will internally damp out vibrations from the fan and reduce or eliminate their transmission and subsequent re-radiation as acoustic noise, thus reducing the sound power transmitted by the computing device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the accompanying drawings in which like reference numerals indicate like elements.

FIG 1 depicts the physical mounting scheme for the attachment of a fan to a heat sink, according to the prior art;

FIG 2 depicts selected elements of a fan sink assembly according to the present invention emphasizing a heat sink, a fan, and an integral fan shroud-vibration isolation component that affixes the fan to the heat sink and prevents the transmission of vibrational energy from the fan to the heat sink;

FIG 3 depicts the integral fan shroud-vibration isolation component of FIG 2 in greater detail;

FIG 4 depicts an embodiment of the integral fan shroud-vibration isolation component comprising co-molded polymer and elastomer elements;

FIG 5 depicts an embodiment of the integral fan shroud-vibrational isolation component comprising metal and elastomer elements;

FIG 6 depicts a fan sink assembly according to the present invention comprising a heat sink, a fan, a fan shroud, and a vibration isolation component that vibrationally isolates the fan and the fan shroud and affixes the fan to the fan shroud;

FIG 7 depicts the vibration isolation component of the embodiment depicted in FIG 6 emphasizing an elastomer element in the form of a gasket; and

FIG 8 depicts the vibration isolation component of the embodiment depicted in FIG 6 emphasizing an elastomer gasket and pre-applied adhesive layers.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0007] The following is a detailed description of example embodiments of the invention depicted in the accompanying drawings. The example embodiments are in such detail as to clearly communicate the invention. However, the amount of detail offered is not intended to limit the anticipated variations or embodiments, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention as defined by the appended claims. The detailed descriptions below are designed to make such embodiments obvious to a person of ordinary skill in the art.

[0008] Generally speaking, the present invention contemplates a fan sink assembly with desirable acoustics characteristics for reduced noise generation in a data processing system. The fan sink assembly includes a heat sink, a fan, a fan shroud, and a vibration isolation component. In use, the assembly affixes to a microelectronic device, such as a microprocessor, affixed to a printed wiring board using a thermally conductive material. The assembly functions to cool the microelectronic device. The heat generated by the microelectronic component transfers to the heat sink by conduction through the thermally conducting materially. The fan moves air through the openings in the heat sink, removing heat from the heat sink by convective cooling. The net effect is to move heat from the microelectronic device to the ambient air, thus cooling the microelectronic device.

[0009] In a conventional fan sink assembly, the fan is rigidly affixed using, typically, four screws to a fan shroud, which in turn rigidly affixes to the heat sink by means of legs. The fan shroud legs are capable of being slightly elastically deformed allowing the shroud and fan

sub-assembly to be affixed to a heat sink. The fan shroud legs then return to their original position, thus affixing the sub-assembly to the heat sink.

[0010] The fan is a rotational device and as such generates a finite amount of vibrational energy as a result of the mass of the fan motor and blades being slightly out of balance around the axis of rotation. Due to the rigid mounting of the fan to the fan shroud, the vibrational energy is transferred to the fan shroud. The fan shroud – fan subassembly is then rigidly mounted to the heat sink, again allowing transmission of vibrational energy to the heat sink. The heat sink may take any of a number of conventional forms, such as a rectangular array of pins (pin-fin heat sink) or thin blades, integrated with a solid base of material to which the fan shroud legs affix. The mechanical structure of the heat sink lends itself to the re-transmission of vibrational energy as sound pressure, thus raising the acoustic noise level of the computing system.

[0011] It is common for such computing systems to have ventilation structures on the front face (the face closest to the operator for a personal computer system). Since the internal structure of the cooling device is designed to move air through the ventilation holes, the sound pressure developed by the vibration of the heat sink will preferentially radiate out of the front of the machine, increasing the noise level of the system relative to the operator.

[0012] The insertion of a vibration isolation component into the fan sink assembly as described herein reduces or prevents the transmission of vibrational energy from the fan to other components to which it is affixed. The reduction or elimination of vibrational energy from the fan reduces or eliminates the vibrational energy which can subsequently be transmitted as acoustic noise.

[0013] Turning now to the drawings, FIG 1 depicts a conventional heat sink, fan, fan shroud (fan sink) assembly **100**. The fan **102** is rigidly affixed to the fan shroud **104** by means of screws **106,** typically located on the four corners of the fan. The result is a fan-fan shroud sub assembly **108**.

[0014] The heat sink **110** includes an array of pins or fins **112** affixed to a solid base **120**. The fan-fan shroud subassembly **108** affixes to the base of the heat sink **120** by means of flexible legs **114** which are capable of deforming elastically a sufficient amount to allow the formed members or feet **116** at the base of the legs **114** to capture the heat sink **110** between opposing pairs of legs **114**.

[0015] Referring now to FIG 2, one embodiment of a fan sink assembly **200** according to the present invention is depicted. The depicted assembly **200** includes a fan **102**, a heat sink **110**, and an integral vibration isolation element-fan shroud **202** that receives and locates the fan **102** relative to the heat sink **110**. In this embodiment, the vibration isolation element **202** serves the purpose of affixing the fan **102** to the heat sink **110** in place of the fan shroud **104** typically used in the currently produced fan-heat sink assemblies. The vibration isolation component **202** is produced from an elastomeric material, of which rubber is an example, having sufficient rigidity to receive the fan and a damping coefficient sufficient to reduce or eliminate the transmission of vibrational energy from the fan **102** to the heat sink **110**.

[0016] Continuing, FIG 3 depicts the integral vibration isolation component-fan shroud **202** of the embodiment depicted in FIG 2. The vibration isolation component-fan shroud **202** includes a carrier structure **301** that defines a cavity **302** of dimensions matched to the dimensions of the fan **102**. The carrier structure **301** includes a base that defines an opening **304** whose dimension matches the active area of the fan **102**, allowing air flow through the vibration isolation component-fan shroud **202** and the heat sink **110**, legs **306** and cross-bands **308** which connect opposing pairs of legs **306**. An opposing cavity **306** captures the top surfaces of the heat sink.

[0017] In use the fan **102** is received into the cavity **302** of the integral vibration isolation component-fan shroud **202**. Since the vibration isolation-fan shroud **202** is made from an elastomeric material, it has an inherent compliance that allows the cavity **302** to deform a necessary to receive the fan **102** and then return to its original shape, retaining the fan **102**. The dimensions of opening **304** in the floor of the fan cavity **302** match the dimensions of the active flow area of the fan **102**. As the fan **102** spins under power, air moved by the fan **102** is free to flow through the opening **302**. Since the fan **102** is encapsulated in the cavity **302** of the vibration isolation component-fan shroud **202**, all air flow related to the fan **102** must go through the heat sink **110**, increasing the cooling efficiency of the heat sink-fan assembly **200** by reducing air flow in non-useful directions. The fan-vibrational isolation-fan shroud subassembly is then affixed to the heat sink **110**. The legs **306** and cross-bands **308** of the vibrational isolation component-fan shroud **202** act like elastic bands due to the elastomeric properties of the material of which it is made, to receive the heat sink **110**, deforming as necessary to receive the heat sink **110** and then returning to their original dimensions, surrounding and retaining the heat sink **110**

in position. The opposing cavity **310** conforms to the perimeter of the top surface of the heat sink **110**, further insuring that all air flow moves through the pins or fins of the heat sink **110**. The elastomeric material used for the integral vibrational isolation component-fan shroud may be a solid elastomer, or a foam elastomer, with its properties designed as required by the vibrational frequency of the energy whose transmission is to be eliminated or reduced and by the dimensional requirements of the mechanical assembly.

[0018] FIG 4 depicts an alternative embodiment of the integral vibration isolation component-fan shroud **400** produced using both an elastomeric material and a rigid polymer. A co-molding process may be used to produce the integral vibration isolation component-fan shroud **400** from the two materials. In this embodiment the fan receiving cavity **302** and opposing cavity **310** are produced from an elastomeric material which will receive and retain the fan **102**. The legs **306** are made from a rigid polymer, while the cross-bands **308** are also produced from an elastomeric material. This embodiment provides increased mechanical stability before the integral vibration isolation component-fan shroud **400** is affixed to the fan **102** and the heat sink **110**. The elastomeric material used within the integral vibrational isolation component-fan shroud may be a solid elastomer, or a foam elastomer, with its properties designed as required by the vibrational frequency of the energy whose transmission is to be eliminated or reduced and by the dimensional requirements of the mechanical assembly.

[0019] FIG 5 depicts an alternative embodiment of the integral vibration isolation component-fan shroud **500** produced using both an elastomeric material and a metal frame, similar to a conventional fan shroud **104**. In this embodiment the metal frame **502** includes a frame, which is over-molded by the elastomer of the cavities **302** and **310**, legs **114** and feet **116**, which serve to affix the shroud **500** to the heat sink **110**. Additional elastomer sections **504** are molded to the feet **116**, isolating the heat sink from the vibration of the fan **102**.

[0020] FIG 6 depicts an alternative embodiment **600** including a fan **102**, a heat sink **110**, a fan shroud **104**, and a vibration isolation component in the form of a gasket **602** which affixes both to the fan **102** and the fan shroud **104**, producing a fan-fan shroud subassembly **108** and vibrationally isolating the fan **102** from the fan shroud **104**. The elastomeric gasket **602** prevents transmission of vibrational energy from the fan **102** to the fan shroud **104**. The fan-fan shroud subassembly **108** affixes to the base of the heat sink **110** by means of flexible legs **114** which are capable of deforming elastically a sufficient amount to allow the formed members or feet **116** at

the base of the legs **114** to capture the heat sink **110** between opposing pairs of legs **114.** The material from which the gasket **602** is made is an elastomeric material, of which natural rubber is an example. It may be a solid elastomer, molded to shape; a foam elastomer, molded to shape; a solid elastomer, stamped from a sheet; or a foam elastomer, stamped from a sheet.

[0021] FIG 7 depicts the vibration isolation gasket **602** of the embodiment depicted in FIG 6. The gasket includes a geometric flat shape **702** approximating the shape and dimensions of the fan **102** and an opening **704** whose dimensions and shape are congruent to the dimensions and shape of the active area of the fan **102.** Air moved by the fan **102** moves through the opening in the gasket **602** to reach the heat sink **110.** An adhesive material, which the required resistance to heat, mechanical strength, and adherence may be dispensed on to one side of the gasket **602** and the gasket affixed to the fan shroud **104.** Adhesive is then applied to the opposing side of the gasket **602** and the fan **102** is affixed to the fan shroud-gasket subassembly. The adhesive layers are cured, typically using a thermal process. The resulting fan-gasket-fan shroud subassembly is then affixed to the heat sink using the elasticity of the fan shroud legs **114** and dimensions of the fan shroud feet **116** as depicted in FIG 1.

[0022] FIG 8 depicts an alternative embodiment **800** of the gasket **602** depicted in FIG 7. Before the assembly to the fan **102** and the fan shroud **104** the gasket material is in the form of a flat sheet. The material may be a solid elastomer material or a foam elastomer material. Pressure sensitive adhesive **802** with a disposable release liner is laminated to opposing sides of the material from which the gasket **602** will be made, forming a composite sheet material. The geometry required by the dimensions of the fan, the outline of the flat shape **702** and the dimensions and location of the opening **704** in the gasket, is produced by stamping from the composite sheet material, producing the gasket-adhesive subassembly depicted in FIG 8. To produce a fan-fan shroud sub-assembly, the disposable release liner is removed from the precut gasket-adhesive, exposing the press-sensitive adhesive. The gasket-adhesive material is then affixed by pressure to the fan **102.** The disposable release liner is then removed from the free side of the gasket-adhesive combination, exposing the second adhesive surface. The second adhesive surface of the fan-adhesive sub assembly is then affixed to the fan shroud **104**, with pressure applied to produce the bond.

[0023] It will be apparent to those skilled in the art having the benefit of this disclosure that the present invention contemplates an improved fan-fan shroud-heat sink assembly which

includes a vibrational isolation component to reduce or prevent the transmission of vibration from the fan to the fan shroud and heat sink. The isolation of the vibrational energy produced by the fan thus reduces or eliminates the energy that can be radiated as acoustic noise by the heat sink-fan assembly, thus producing an acoustically quieter computer system. It is understood that the form of the invention shown and described in the detailed description and the drawings are to be taken merely as presently preferred examples. It is intended that the following claims be interpreted broadly to embrace all variations of the preferred embodiments disclosed.